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# Activities related to the occurrence of traumatic dental injuries in 15- to 18-year-olds

### Boyen Huang<sup>1</sup>, Wagner Marcenes<sup>2</sup>, Ray Croucher<sup>2</sup>, Mark Hector<sup>3</sup>

<sup>1</sup>School of Dentistry, University of Western Australia, Nedlands, WA, Australia; <sup>2</sup>Centre for Clinical and Diagnostic Oral Sciences, Barts and The London School of Medicine and Dentistry; <sup>3</sup>Centre for Oral Growth and Development, Barts and The London School of Medicine and Dentistry, Queen Mary, University of London, London, UK

Correspondence to: Boyen Huang DDS, MHA, PhD, School of Dentistry, University of Western Australia, 17 Monash Avenue, Nedlands, WA 6009, Australia Tel.: +61 8 9346 7642 Fax: +61 8 9346 7666 e-mail: boyen.huang@uwa.edu.au Accepted 19 November, 2007 **Abstract** – *Objective:* To assess the activities related to the occurrence of traumatic dental injuries (TDI) in order to establish the relationship between gender, socio-economic status (SES) and major TDI related events, using classification and examination procedures suitable for epidemiological purposes, in a sample of 15- to 18-year-old students in Taiwan.

*Methods:* A random sample of 6312 15- to 18-year-old senior high school students in southern Taiwan was selected. Each was examined with standard clinical procedures and a questionnaire.

*Results:* The prevalence of TDI was 19.9%. The major TDI related events included sports and leisure activities (30.8%), eating (20.5%), falls (19.4%), traffic accidents (10.2%) and collisions (7.1%). Within TDI victims, sports and leisure related TDI were more prevalent among males (P = 0.001, OR = 1.640, 95% CI = 1.225, 2.195) and high SES adolescents (P = 0.014, OR = 1.991, 95% CI = 1.149, 3.449). The occurrence of non-accidental TDI was not related to age, gender and SES ( $P \ge 0.643$ ).

*Conclusion:* Traumatic dental injuries have become an important issue in public health and dentistry. Prevention and treatment of TDI should be emphasised to the public, the health professional and the policy maker. Future investigations into the relationship between TDI related events and their determinants are indicated.

Activities related to the occurrence of traumatic dental injuries (TDI) have been reported. Our quasi systematic review of TDI related events concluded that few valid and reliable studies have reported the activities involved at the time when TDI occurs (1). Our literature search included Medline, PubMed databases, books and reports published between 1970 and 2001 (1). A further review of literatures published between 2001 and 2007 was also conducted for this study. All papers presenting original data on TDI related events were selected. Previously recognised criteria (2) were applied in our critical appraisal of the literature.

Out of 12 studies presented only 11 papers were considered acceptable (3–13). The major methodological weakness identified was an unsatisfactory approach towards selecting the sample and calculating the sample size. Most published data on the aetiology of TDI were clinic- and hospital-based studies, and the size of the samples yielded poor precision. Thus, these results cannot be inferred to the general population (14). The main TDI related events reported in acceptable publications were violence (range: 1.2-70.6%), collisions (range: 1.7-65.3%), falls (range: 8.3-54%), sports (range: 2.3-49.4%), leisure activities (range: 8.9-36.6%) and traffic accidents (range: 0.6-24.1%). These commonly reported TDI related events, and the continuing use of unsatisfactory study designs were confirmed after updating our quasi systematic review. Therefore, most findings on TDI related events might have been improperly estimated because of the lack of validity of these findings.

Reliable and valid data on TDI related events are relevant to further understanding the aetiology of TDI and developing effective preventive and therapeutic strategies. The aim of this study was to assess TDI related events using a methodologically sound study design, and to establish the relationship between gender, socio-economic status (SES) and major TDI related events, in a sample of 15- to 18-year-old students in Taiwan.

#### Materials and methods

This cross-sectional study was conducted in Kaohsiung City, the largest urban area in southern Taiwan. The investigation was conducted under the authorisation of the Kaohsiung City Government, school staff, and students' parents from October 2002 to January 2003. A pilot study was carried out to test administration of questionnaires and dental examination procedures. The results confirmed that the protocol was feasible for the target population.

The population included all male and female senior high school students aged 15 to 18 in Kaohsiung City. The size of the sample was calculated for reporting TDI related events with satisfactory precision. We estimated that 807 subjects was the minimum number of subjects for reporting 95% confidence limits for the prevalence of TDI related events with a standard error of less than 3.5%. This calculation assumed a prevalence of TDI related event equal to 50%. This decision was because of any other prevalence would require a smaller sample size. Finally, we estimated that we needed to screen at least 5380 adolescents to identify a minimum of 807 sustaining TDI, the sample size for reporting the TDI related events. This was calculated assuming a prevalence of TDI higher than 15%, as from previous presented data (1). A possible negative response rate of 20% further raised the estimation to 6725 students.

A cluster random sampling technique was used to select the sample from all relevant 29 schools. Four of the thirty-three senior high schools in Kaohsiung City were excluded from the study sample as three were established for students with special needs whilst the other was newly created with no students aged above 16. The total number of schoolchildren was 57 302 distributed in 1395 classes. The average number of student in each class was 41 indicating a minimal requirement of 175 classes to compose the total sample. Classes were systematically selected from the sampling frame using a sampling fraction of one-eighth to assure proportional representation. This was calculated by dividing the number of classes needed by the number of total classes, 175 and 1395, respectively. All students who attended school in the selected classes and gave positive consent on the day the researcher visited the school were clinically examined and interviewed by one trained dentist (B.H.).

Participants were examined at school during class hours. Dental examinations included upper and lower incisors, canines and adjacent soft tissues. The examiner recorded the type of damage sustained and any treatment provided or needed because of TDI. The criteria for occurrence of TDI included treated and untreated fracture of enamel, enamel and dentine with or without pulp involvement, discoloration and tooth loss because of TDI (12). A strict cross-infection control was adopted. The examiner used disposable gloves and packages with plane mirrors, CPI periodontal probes and gauze pads were sterilised in sufficient number for a day of work. Intra-examiner variability was checked through duplicate examination of every tenth participant. A questionnaire was used to assess socio-demographic and economic data including sex, age and parent's level of education. In addition, all children who had TDI were asked to provide details of the TDI related event. These details included place and activity performed when the incident happened, and the human intention (accidental or non-accidental).

Data entry and statistical analysis were carried out with the STATISTICAL PACKAGE FOR SOCIAL SCIENCES (SPSS/PC for Windows, version 13.0, SPSS Inc., Chicago, IL, USA). Data analysis included descriptive statistics (frequency distribution and cross tabulation). Statistical significance for differences was assessed using the chi-squared test. Multivariate logistic regression was used to assess the individual contribution of variables studied. The level of significance was set at 5%. The kappa statistic test was used to verify reliability of the data, and it was performed on a tooth-by-tooth basis.

# Results

All schools agreed to participate in the study, and 6625 out of 7328 students were screened for TDI providing a response rate of 90.4%. Another 313 were excluded from data analysis because of incomplete information. The final sample included 6312 pupils (86.1%). Kappa values were calculated on a tooth-by-tooth basis, and the results indicated very good intra-examiner agreement. Kappa values ranged from 0.85 to 1.00. Table 1 showed the frequency distribution of participants' age.

The overall prevalence of TDI to permanent anterior teeth in schoolchildren aged 15- to 18-year-old was 19.9% (95% CI: 19.0%, 21.0%), and 19.2% (95% CI: 18.2%, 20.2%) when canines were excluded. Most TDI occurred at home (29.1%), school (23.7%), or public places such as roads and parks (11.1%). Differences in prevalence between ages were not of statistical significance (P = 0.601, Table 1). Male adolescents sustained TDI more often than females (OR = 1.764, 95% CI: 1.554, 2.003, P < 0.001; Table 2). The relationship between the head of family's level of education and TDI was not clear. A gradient was not observed and the test for trend confirmed that there was not a statistically significant trend suggesting a lack of association. The lowest prevalence of TDI was observed in schoolchildren from families whose head had secondary education (Table 2).

The frequency distribution of TDI related events is presented in Fig. 1. This data analysis included 975 subjects as 284 (22.6%) of those sustaining TDI did not remember the TDI related events. The major TDI related event was sports and leisure (30.8%, 95% CI: 27.9%, 33.8%), followed by eating (20.5%, 95% CI: 18.1%, 23.2%), falls (19.4%, 95% CI: 17.0%, 22.0%), traffic accidents (10.2%, 95% CI: 8.4%, 12.3%), collisions (7.1%, 95% CI: 5.6%, 8.9%), inappropriate use of teeth (4.8%, 95% CI: 3.6%, 6.4%), violent incidents (3.7%, 95% CI: 2.6%, 5.1%), hitting an object (1.3%, 95% CI: 0.7%, 2.3%), being hit by an object (0.9%, 95% CI: 0.5%, 1.8%), iatrogenic damage (0.7%, 95% CI: 0.3%, 1.5%) and self-inflicted injuries (0.6%, 95% CI: 0.3%, 1.4%). Intentional TDI such as violence and self-inflicted incidents contributed to only a small proportion of TDI in this population, 4.3% (95% CI: 3.2%, 5.8%), and it was not significantly associated with age, gender and family head's level of education ( $P \ge 0.643$ ).

TDI related to sports and leisure was not associated with age (P = 0.118) when compared to all other TDI related events. Males had a higher likelihood of TDI resulting from sports and leisure events than females

*Table 1.* Frequency distribution of age, and prevalence of traumatic dental injuries (TDI) by age in a sample of 6312 schoolchildren in Taiwan

Age in years	Frequency (%)	Frequency of TDI (%)	<i>P</i> -value	
15	1586 (25.1)	295 (18.6)	0.601	
16	2005 (31.8)	409 (20.4)		
17	2036 (32.3)	436 (21.4)		
18	685 (10.8)	119 (17.4)		
Total	6312 (100.0)	1259 (19.9)		

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<i>Table 2.</i> Frequency distribution of traumatic dental injuries (TDI) by gender and family head's level of education in the sample of the study ( $n = 6312$ )										
	TDI [ <i>n</i> (%)]	No TDI [ <i>n</i> (%)]	All [ <i>n</i> (%)]	Unadjusted OR (95% CI)	<i>P</i> -values	Adjusted OR (95% CI)	<i>P</i> -values			
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Gender							
Female	479 (15.5)	2619 (84.5)	3098 (49.1)	1		1	
Male	780 (24.3)	2434 (75.7)	3214 (50.9)	1.752 (1.544, 1.988)	< 0.001	1.764 (1.554, 2.003)	< 0.001
Family head's level of education							
Primary	139 (19.1)	590 (80.9)	729 (11.5)	1		1	
Secondary	808 (21.2)	3004 (78.8)	3812 (60.4)	1.142 (0.934, 1.395)	0.195	1.096 (0.896, 1.341)	0.373
Tertiary	312 (17.6)	1459 (82.4)	1771 (28.1)	0.908 (0.727, 1.133)	0.392	0.852 (0.681, 1.065)	0.159



Fig. 1. Percentage distribution of causes of traumatic dental injuries in the sample of the study (n = 1259).

*Table 3.* Frequency distribution of sports and leisure related traumatic dental injuries (SLTDI) by gender and family head's level of education in the sample of the study (n = 975)

	SLTDI [ <i>n</i> (%)]	No SLTDI [ <i>n</i> (%)]	All [ <i>n</i> (%)]	Unadjusted OR (95% CI)	<i>P</i> -values	Adjusted OR (95% CI)	<i>P</i> -values
Gender							
Female	90 (24.3)	281 (75.7)	371 (38.1)	1		1	
Male	210 (34.8)	394 (65.2)	604 (61.9)	1.664 (1.245, 2.225)	0.001	1.640 (1.225, 2.195)	0.001
Family head's le	evel of education						
Primary	21 (21.0)	79 (79.0)	100 (10.3)	1		1	
Secondary	190 (30.4)	434 (69.6)	624 (64.0)	1.647 (0.988, 2.744)	0.055	1.587 (0.950, 2.653)	0.078
Tertiary	89 (35.5)	162 (64.5)	251 (25.7)	2.067 (1.197, 3.569)	0.009	1.991 (1.149, 3.449)	0.014

(OR = 1.640, 95% CI = 1.225, 2.195, P = 0.001). There was a clear association between sports and leisure TDI and the head of family's level of education. A gradient statistically significant trend was observed, and schoolchildren who had family heads with tertiary education were twice (OR = 1.991, 95% CI = 1.149, 3.449; P = 0.014) more likely to sustain sports and leisure related TDI than pupils in families whose heads completed primary education only (Table 3).

# Discussion

The high prevalence of TDI observed in this population is in agreement with previous studies, and suggested that TDI is a developing dental public health challenge in Taiwan (3, 6, 7). Comparison of our results with other studies in relation to TDI related events was challenging because of a lack of standardisation in reporting TDI related events in the literature. Therefore, comparisons were made only when the same criteria were used.

As expected sport and leisure TDI were the most common of all TDI related events. This study demonstrated a significant association between TDI resulting from sports and leisure events and high education of family heads rather than low formal education. High levels of education tended to lead to better jobs and higher incomes (15), so children having family heads with tertiary education were assumed to come from a higher SES background. Sports and leisure events could be more accessible and affordable to adolescents coming from a higher SES background and consequently they are more likely to be exposed to a raised risk of sports

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and leisure related TDI. A higher prevalence of sports and leisure related TDI was found in boys. Male students in Taiwan spent more time in physical activity (16) and this could explain the higher prevalence of sport and leisure related TDI reported here.

A high proportion of TDI involved with eating was reported in this study. Traebert et al. found less than 3% of TDI resulting from eating (4), whilst others did not specify any eating related TDI. The unique dietary culture of Taiwan could be the reason for this: crunching bones and dismembering crab shells with teeth are common. Al-Majed et al. suggested a similar scenario with the connection between Saudi adolescents' TDI and their eating raw nuts and dried melon seeds (17).

The percentage of TDI because of falls and collisions in this study was much lower than those suggested by most researchers (3–5, 7, 9–11). Only Blinkhorn reported a similar prevalence of TDI caused by falls (8). The discrepancy may be the result of using a refined approach to assess TDI related events (7). The concept of differentiating mechanisms and activities was applied in the International Classification of External Causes of Injuries (ICECI) (18), which may establish a more clear specification of TDI related events.

This study displayed a higher proportion of TDI resulting from traffic accidents than most others (3, 4, 6-8, 10), agreeing with the findings of Nicolau et al. (9) and Marcenes et al. (12). This could be interpreted as a consequence of the higher incidence of traffic accidents in Taiwan. The injury and death rates involved with road crash in Taiwan were two and four times of those in the UK, respectively (19, 20).

Inappropriate use of teeth was responsible for 4.8% of TDI in this sample. Only one study has reported a TDI cause as misuse of teeth, which displayed a proportion at 6% (9). Although the percentage was low, several bizarre TDI related events were noted in this study, including opening a bottle top, holding staplers, adjusting a watch or a pair of compasses and opening a key ring.

Intentional TDI related events including violence and self-inflicted incidents contributed to a small proportion of TDI in this study. The similarly low prevalence of violence related TDI has been reported (3–5, 7–9) although it is at variance with the studies conducted in Iraq (10), Sudan (10) and Syria (12). Gender, age and SES were not related to the occurrence of TDI resulting from non-accidental incidents. This could be due to underestimation of intentional TDI because intentions of incidents were not specifically surveyed in this study. Some TDI cases resulting from falls, collisions, hitting by an object and even sports/leisure events could be applied in future studies as classifying intentions of injuries is included in the scheme (18).

More than 20% of TDI victims in this study failed to recall details of their TDI experiences. Respondents could forget these because it occurred long time ago, but unknown TDI might also be associated with amnesias or concealment. Functional amnesic states could be triggered by environmentally induced stress and trauma and lead to a lasting inability to retrieve autobiographical events (21). Some researchers inferred that violence victims tended to report an unknown reason of TDI (7, 9). Therefore, TDI caused by violence or along with severe general injuries could be underestimated.

# Conclusion

The study has manifested an enhancing effect of high SES on the occurrence of TDI resulting from sports and leisure events. In addition, the higher proportion of males sustaining sports and leisure related TDI has been once again confirmed by this study.

Relevant TDI related events verified in the study, including sports and leisure events, followed by eating, falls, traffic accidents, collision, inappropriate use of teeth, and violent incidents have been identified. Additional findings on TDI related events such as iatrogenic damage and self-inflicted injury have been reported.

Traumatic dental injury has become an important issue in public health and dentistry. Prevention and treatment of TDI should be emphasised to the public, health professionals and policy makers. Succeeding investigations into the relationship between TDI related events and determinants of TDI are indicated.

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